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Transient Particulate Matter Measurements from the Exhaust of a Direct Injection Spark Ignition Automobile

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ABSTRACT

Diesel and gasoline engines face tightening particulate matter emissions regulations due to the environmental and health effects attributed to these emissions. There is increasing demand for measuring not only the concentration, but also the size distribution of the particulates. Laser-induced incandescence has emerged as a promising technique for measuring spatially and temporally resolved soot volume fraction and size. Laser-induced incandescence has orders of magnitude more sensitivity than the gravimetric technique, and thus offers the promise of real-time measurements and adds information on the increasingly desirable size and morphology information. Quantitative LII is shown to provide a sensitive, precise, and repeatable measure of the soot concentration over a wide measurement range.

The current research determined the tailpipe particulate emissions characteristics from a DISI (direct injection spark ignition) vehicle, including identifying the relative contributions of various engine modes to the total particulate emissions. The volume concentration measurements were obtained in the undilute exhaust with laser-induced incandescence (LII). Particulate measurements were also performed with ELPI instrumentation, sampling from a mini-diluter. Gravimetric filter sampling was performed to measure mass emission rate, organic/elemental carbon, and sulphates/nitrates/trace elements.

The LII technique was demonstrated to be capable of real-time particulate matter measurements over all vehicle transient conditions. The wide measurement range and lower detection limit of LII make it a potentially preferred standard instrument for soot measurements.